

Roentgen Therapy of Rheumatoid Spondylitis

NATHAN M. SPISHAKOFF, M.D., *Beverly Hills*, and B. V. A. LOW-BEER, M.D.,
San Francisco

SUMMARY

Based on the pathological processes involved in rheumatoid spondylitis, comparison is made between the physical qualities of certain techniques of roentgen therapy. Graphic representation of the isodose curves and the homogeneous distribution of radiation pertaining to the method herein advocated is shown.

Results obtained in the treatment of 125 cases illustrative of the evolution of technique experienced at the University of California Hospital are tabulated. The indications, contraindications, and complications of the method are discussed.

Practically every patient with rheumatoid spondylitis, regardless of the stage of the disease, was benefited, with the best results having been obtained when the radiation was given in three courses, separated by rest periods, and homogeneously distributed along the spine.

FIFTY years have passed since x-rays were first used in the treatment of spondylarthritis, for the reports by Stenbeck and by Sokolow appeared in the foreign literature in 1898, only three years after Roentgen's discovery of the rays. Anders, Daland and Pfahler¹ (1906) are credited with the first report in this country.

Since then, and especially following the stimulus generated by Smyth, Freyberg and Lampe⁹ in 1941, the use of roentgen irradiation in combatting rheumatoid spondylitis has become widespread. Numerous variations in physical factors and treatment techniques have been used, all apparently with fairly good results.

This discussion is concerned with the technique evolved and the experience gained in the treatment of patients referred to the therapy section of the department of radiology at the University of California Hospital between 1942 and 1948. Most of the patients came from the arthritis clinic, where the

diagnosis was established after complete preliminary study by the arthritis committee. Some patients referred by private physicians are also included in the analysis.

It is not the purpose of this report to enter the argument concerning etiology, or whether rheumatoid spondylitis and rheumatoid arthritis are manifestations of the same or different disease entities. Similarly the well established clinical and roentgen criteria for diagnosis will not be reviewed. However, it should be mentioned that the high incidence of peripheral joint involvement noted in this group appears to be more than mere coincidence, and suggests that stronger consideration should be given to the concept of a systemic disease affecting either the joints of the spinal axis, or the peripheral joints, or both.

Because of the difficulty in obtaining material for microscopic study, the actual changes which occur within the affected joints have not been unequivocally established except in advanced cases of long duration that came to autopsy for other reasons. However, the disease has been classified by the American Rheumatism Association in the category "Probably Infectious (Etiology Not Known)," in which are also included rheumatic fever, rheumatoid arthritis and Still's disease. Steinberg¹⁰ and Angevine² are in essential agreement with regard to the pathological findings, and have clarified the situation to some extent. The joints involved contain synovial membrane and articular cartilage. The initial response to the disease has been noted as synovial inflammation and edema, with thickening and infiltration of the subsynovial tissues by lymphocytes, monocytes, and plasma cells. Fibrinoid material, sometimes several layers thick, deposits over the surface of the synovial lining. Apparently, the next phase of the process is the proliferation of fibrous connective tissue in the region of the perichondrium, forming a vascular granulation tissue pannus which spreads over the surface of the articular cartilage, resulting in disturbed nutrition of the cartilage and consequent disintegration of it. Because of its close approximation the pannus tends to fuse with that covering the opposing cartilage, and in the subsequent attempt at repair, fibrous ankylosis and even bony fusion becomes the end result. It is apparent, therefore, that the disease is a chronic mesenchymal inflammatory disorder of the reticuloendothelial system.

In the attempt to control the crippling effects of the disease, a variety of techniques of x-ray therapy using beams of diverse physical qualities has been

From the Division of Radiology, University of California Medical School, San Francisco, California.

Presented before the Section on Radiology at the 77th Annual Session of the California Medical Association, San Francisco, April 11-14, 1948.

The cooperation and assistance given by the physicians who permitted access to their private records is gratefully acknowledged.

utilized. Of these, the method known as "wide-field" technique, devised by Scott,⁸ has gained considerable prominence and numerous advocates both here and abroad.

Using x-rays generated by 130-140 kv, with 3 mm. aluminum added filtration, or 100 kv with 1 mm. aluminum added filtration, Scott initially covered the whole trunk in two overlapping fields approximately 30 centimeters in diameter. Later, with the use of a specially designed wide angle tube, covering a diameter of approximately 54 centimeters at a tube-skin distance of 40 cm., he irradiated the entire torso in a single field, delivering 60-100-r (air) at the center of the field.

He stated that uniform distribution of radiation over the field was not essential, but instead attempted to endow the patient with a generalized or "constitutional stimulating effect" or "state," which he called "saturation."

It is not within the province of this presentation to discuss whether or not roentgen irradiation, of either long or short wave length, has a stimulating effect. However, confirmation of the lack of uniformity of absorption in the field of treatment is easily established, by reference to isodose charts. The authors have been unable to find such graphs for the "wide-angle" tube, but curves applicable to the beam used by the advocates of the so-called "modified Scott wide-field technique" are available (Figure 1).

The joints of the spine with which we are concerned lie at an approximate depth of 6 to 7 centimeters from the overlying skin surface. The differential of absorption between the center and the periphery of the field, at this level, is readily appreciated. An even greater gradient would be expected with the single large field.

In contradistinction to the method just described, McWhirter⁶ treats locally to the area of the sacro-iliac joints and the lumbar spine, using long narrow fields, and utilizes the considerably harder radiation generated with 250 kv and 1 mm. steel (inherent) filtration, giving daily treatment to a total of 2,500 r (skin). On occasion, he treats the entire length of the spine with similar dosage. Pohle and Morton⁷ also use beams of shorter wave length, generated by 200 kv, or 400 kv, with half-value layers of 1.05 mm. copper and 2.4 mm. copper, respectively, and treat three elongated areas to a total of 450-600 r (air) in three to six days. Similar factors are advocated by Hemphill⁵ and Reeves, and by Baker.³

Except for Freyberg and his associates, the courses of treatment were repeated only upon recurrence of symptoms. Freyberg now advocates repetition of the course of treatment three times, at four to six week intervals, but in his last report⁴ states that fewer complications develop if rays of longer wave length, generated by 140 kv, are used.

TECHNIQUE

The method of treatment at the University of California Hospital has undergone a process of gradual evolution since its inception during the latter part of 1941. At first, treatment was directed locally to painful areas only, usually the region of the lumbar spine and sacro-iliac joints. Later, using moderately elongated fields, the thoracic spine was included. Courses of treatment were repeated only upon recurrence of symptoms.

The use of relatively small fields extending along the entire spinal axis has been practiced since 1944. In people of average length, four portals are placed longitudinally along the vertebral column, with a single field placed horizontally to cover the sacro-

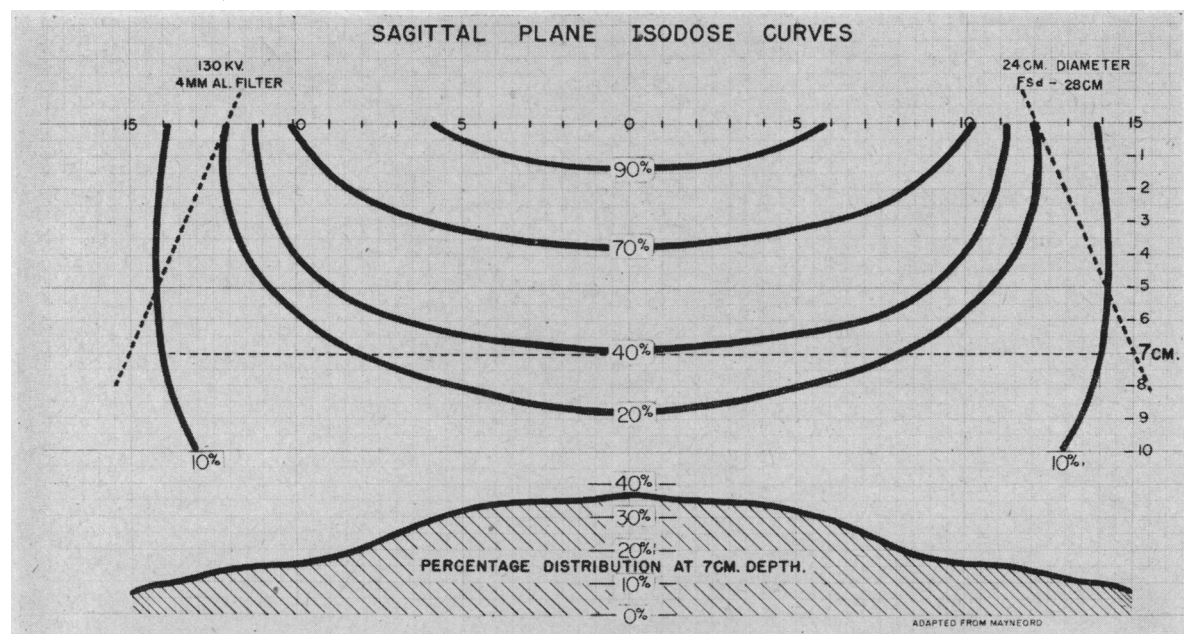


Figure 1

iliac joints. The most superior field measures 10 x 10 cm., and the others are 10 x 15 cm. In shorter people, the spine is easily covered by three 10 x 15 cm. portals placed longitudinally, the sacro-iliac port being transversely situated as before. The fields are delineated by an indelible skin-marking ink, so that the treatment cone may be identically placed each time. This inked boundary of adjacent portals results in separation of the fields by 5 to 7 millimeters.

Using x-rays generated by 200 kv constant potential, HVL 1.05 mm. copper, 50 cm. target-skin distance, and an output of approximately 45 r per minute, 200 r (air) are delivered to the upper and lower halves of the vertebral column and paraspinal musculature on alternate days, for a total of 600 r (air) per field. Isodose curves illustrative of these factors are indicated in Figure 2.

For treatment of a chronic inflammatory lesion on the surface, it is desired to deliver 75 to 150 r to the process at each treatment. For surface lesions, beams of "softer" quality are adequate, but in order to deliver the same dose at the depth with which we are concerned, it is felt that a beam of the quality described is more appropriate. The 200 r (air) is equal to 263 skin roentgens on the 100 square centimeter field, and 273 skin roentgens on the 150 square centimeter fields. At the average depth of 7 centimeters, the calculated tissue dose therefore is 121 r and 134 r respectively.

Graphic illustration of the resultant distribution of the radiation, as shown by sagittal plane isodose curves superimposed along the spine, corresponding to the portals of the incident beam, are shown in Figure 3.

That this accomplishes homogeneous irradiation in the region of the apophyseal and sacro-iliac joints of the spine is indicated in Figure 4, which repre-

sents the percentage depth dose in the sagittal plane, at a depth of 7 centimeters from the skin surface. The small peaks or "hot spots" caused by the over-

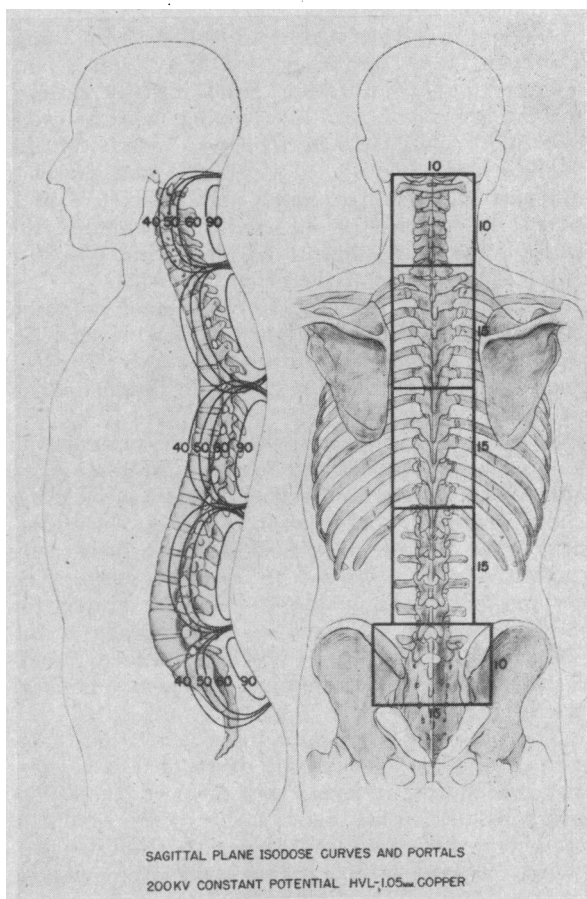


Figure 3

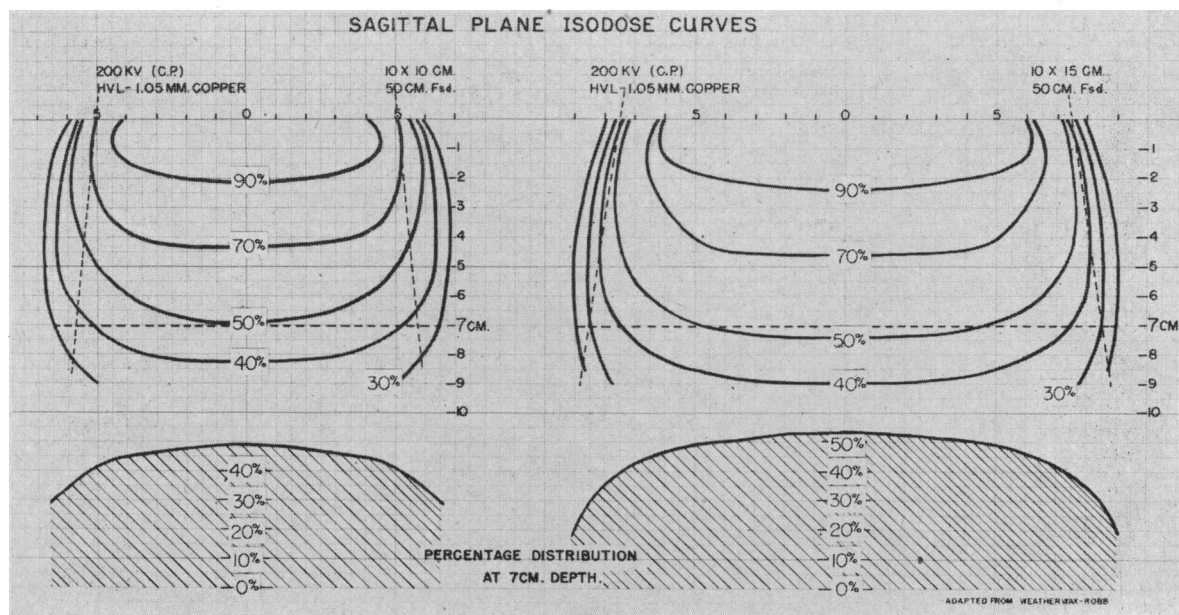


Figure 2

lapping divergence amount to only approximately 10 per cent. This becomes necessary if radiation sufficient to control the chronic inflammatory state is to be delivered.

After a rest period of four weeks, a second identical course of treatment is given, and after a second rest period of 12 weeks, the third and final course of treatment is administered.

Since the latter part of 1941, a total of 167 patients with rheumatoid spondylitis have been treated. Of these, 42 were excluded from the reported series because of incomplete data.

The 125 cases analyzed have been subdivided into four groups: (1) those receiving three courses; (2) those receiving two courses; (3) those receiving a single course, and (4) those receiving local treatment. Since division into stages of disease, as indicated by roentgen findings, is at best an arbitrary classification not particularly dependent upon the duration or severity of symptoms, such segregation has not been attempted.

Instead, the response of the group, without regard to such staging, has been taken as a test of the efficiency of the method in control of symptoms and prevention of recurrence, since pain may be alleviated and muscle spasm relieved, even in the most advanced stages.

The cases are broken down according to sex and age of the patients at the time treatment was started, as indicated in Table 1.

Subsequent to the completion of each course of treatment, the patients were followed by the referring physicians, with such orthopedic and general supportive measures and physical therapy as was deemed necessary. Prior to each course of roentgen therapy, and oftener if indicated, a complete blood cell count and sedimentation rate determination was obtained.

Response was measured subjectively and objectively and recorded as the consensus of the arthritis committee or by the private physician. Subjective criteria included presence or absence of pain, ability to assume a single position for any considerable period of time, and ability to sleep.

TABLE I

AGE	THREE COURSES		TWO COURSES		ONE COURSE		LOCAL	
	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE	MALE	FEMALE
15 - 19	1	1	0	1	0	0	1	0
20 - 24	5	1	4	2	0	2	0	0
25 - 29	12	2	5	1	2	0	4	0
30 - 34	9	2	3	4	1	1	1	0
35 - 39	15	2	5	0	1	0	0	0
40 - 44	13	0	4	2	1	1	0	0
45 - 49	1	3	0	0	0	1	0	0
50 - 54	4	1	2	1	0	0	0	0
55 - 59	0	0	0	1	1	0	0	0
60 +	1	0	0	0	0	0	0	0
TOTAL	61	12	23	12	6	5	6	0
NET TOTAL	73		35		11		6	

Objective criteria included blood cell counts and sedimentation rates, degree of mobility of the spine, increase in chest expansion, correction of postural defects, change in weight, and, in a few instances, comparative roentgenograms of the spine.

EVALUATION OF RESULTS

Table 2 indicates the period over which the patients were followed for determination of response:

In order to properly evaluate a therapeutic modality, any associated undesirable reactions or effects must be weighed against the benefits. The more significant of these complications are gastro-intestinal disturbances, usually transient in nature, which occur concomitantly with the series of roentgen treatments. Of more grave significance is the development of leukopenia, which usually appears subsequent to a treatment course. A count of less than 4,000 leukocytes has been considered indicative of leukopenia. In addition, menstrual dysfunction or amenorrhea may occur in females of child-bearing age. But except for the latter effect, which may be permanent, the most important consideration is the incidence of recurrence of symptoms in the back.

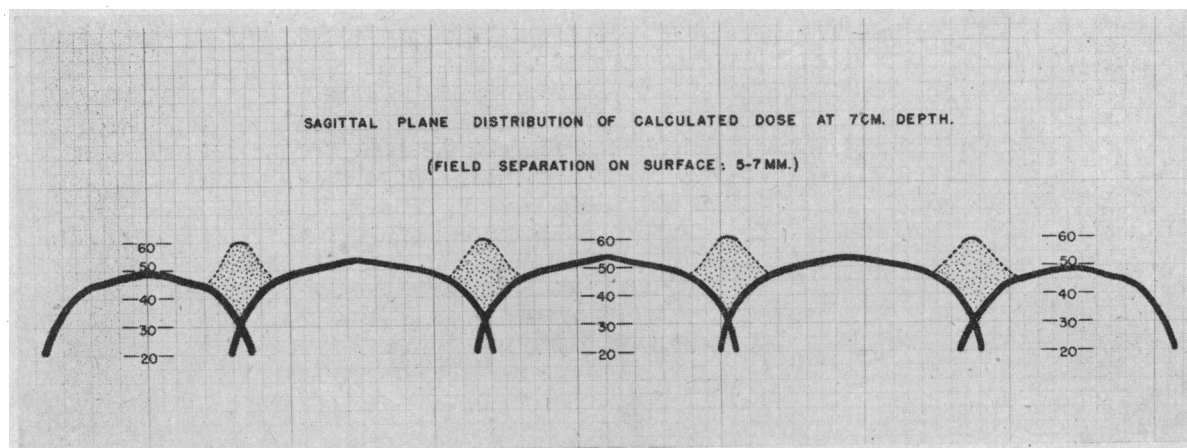


Figure 4

Symptoms were not relieved, or they recurred, in 10 of 73 patients (13.8 per cent) treated with three courses; in 13 of 35 patients (37.1 per cent) receiving two courses, and in 6 of 11 patients (54.5 per cent) receiving only a single course. All the patients treated locally suffered recurrence, and subsequently were given treatment to the whole spine, three having received three courses, two having received two courses, and one a single course.

These findings, the other complicating reactions, and the incidence of associated peripheral joint involvement are summarized in Table 3:

Several pertinent facts become apparent as these results are studied. Any active case of rheumatoid spondylitis warrants roentgen therapy, regardless of the duration and severity of symptoms, or stage of disease as indicated by roentgenograms. For a

patient with even the most advanced case will probably be relieved of pain and muscle spasm, while increased motion of the spine and thoracic cage will be regained by those in whom fixation and ankylosis has not occurred, especially if orthopedic and general supportive measures are prescribed in association.

No actual contraindications to roentgen irradiation exist, except that treatment should be withheld if leukopenia is noted. Local heat, diathermy, and infra-red lamps should be avoided during and approximately two weeks before and after a course of x-ray, in order to avoid an undesired skin reaction.

The complications to be expected have been mentioned. Of these, only artificial menopause appears to be permanent, but fortunately the incidence appears quite low. Leukopenia may occur, apparently more likely in women, without regard to age, but is transient in nature. Similarly the gastro-intestinal disturbances clear soon after a course of treatment, and may be moderated if not completely controlled by the use of parenteral vitamin B components, trisentine and phenobarbital, or such anti-histaminic agents as pyribenzamine or benadryl.

Although in many cases there was a drop in sedimentation rate, the real value of the test as a good criterion of therapeutic response appears doubtful. At least it did in this series. Since 48.8 per cent of those treated had involvement of the peripheral joints as well as the spine, indicating the systemic nature of the process, a permanent drop in the sedimentation rate could hardly be expected unless the spine were the only site of disease activity. However, it is not disputed that the sedimentation rate remains of value in initially establishing the diagnosis.

DISCUSSION

The results obtained after treatment locally, compared to one, two, or three courses to the entire spine, indicate that the three-course technique with properly spaced rest periods is the most efficient in permanent relief of symptoms. The dose delivered by the latter method is in accord with the principles of therapy for chronic inflammatory processes, and explains the relief of pain and muscle spasm. Although microscopic proof is lacking, the radiobiological effect probably is primary in the action on the lymphocytes, monocytes and plasma cells infiltrating the synovial and subsynovial tissues.

The destruction of the leukocytic infiltration as the result of the first course of treatment probably accounts for the initial relief noted by most patients. Recovery of injured cells leads to resurgence of the low grade inflammation, which again is dampened by the second course of treatment. The residual inflammatory components, more likely to have been injured by the two previous exposures to radiation, are less likely to recover, and are more likely held in permanent abeyance by the third series. If these circumstances exist, the need for homogeneous distribution of the radiation becomes more apparent.

TABLE II
CASES ACCORDING TO FOLLOW-UP INTERVAL

	THREE COURSES	TWO COURSES	ONE COURSE	LOCAL
1-5 MOS	26	14	3	2
6-12 MOS	17	5	1	0
1-2 YRS	15	5	1	2
2-3 YRS	10	8	2	0
3-4 YRS	4	2	1	0
4-5 YRS	1	1	2	0
OVER 5 YRS	0	0	1	2
TOTAL	73	35	11	6

TABLE III
COMPARISON OF RESULTS

	G-I DISTURBANCES		LEUCOPENIA		AMENORRHEA	RECURRENT BACK SYMPTOMS	PERIPHERAL INVOLVEMENT		
	AGE	MALE	FEMALE	MALE			FEMALE	MALE	FEMALE
THREE COURSES (73 CASES)	15-19	1	0	0	1	0	1 AT 18 MONTHS	1	1
	20-24	3	1	1	1	0	—	5	1
	25-29	3	0	1	1	2	1 AT 12 MONTHS	7	0
	30-34	0	0	0	1	1	1 AT 4 MONTHS	1	0
	35-39	6	0	2	0	1	1 AT 12 MONTHS 1 AT 15-19-23 MOS 2-NO RESPONSE	4	1
	40-44	4	0	0	0	0	1 AT 18 MONTHS 1 AT 3 YRS (CERVICAL)	7	0
	45-49	1	3	0	0	0	—	0	1
	50-54	0	0	0	1	0	1 AT 2 MONTHS	1	1
	55-59	0	0	0	0	0	—	0	0
	60+	0	0	0	0	0	—	1	0
	TOTAL	18	4	4	5	4	10	27	5
NET TOTAL	22		9		4	10 (15.8%)	32		
TWO COURSES (35 CASES)	15-19	0	0	0	0	0	1 AT 6 MONTHS	0	1
	20-24	3	0	0	1	0	1 AT 3-13 MONTHS	2	2
	25-29	2	1	0	1	1	1 AT 1 MONTH 1 AT 18 MONTHS 1 AT 4-24 MONTHS	2	0
	30-34	1	2	0	1	2	1 AT 3 MONTHS 1 AT 4-8 MONTHS 1 AT 14-26 MONTHS	2	3
	35-39	1	1	0	0	0	1 AT 7 MONTHS	3	0
	40-44	3	1	1	1	0	1 AT 5 MONTHS 1 AT 4 MONTHS	3	2
	45-49	0	0	0	0	0	—	0	0
	50-54	0	1	0	0	0	1 AT 6 MONTHS	1	1
	55-59	0	0	0	0	0	1 AT 2-4 MONTHS	0	1
	TOTAL	10	6	1	4	3	13	13	10
	NET TOTAL	16		5		3	13 (37.1%)	23	
ONE COURSE (11 CASES)	20-24	0	1	0	0	0	1 AT 3-6-18 MOS	0	1
	25-29	1	0	0	0	0	1 AT 17 MONTHS	1	0
	30-34	0	0	0	1	0	1 AT 24-48 MOS	1	1
	35-39	0	0	0	0	0	—	0	0
	40-44	0	0	0	0	0	1 AT 5 MONTHS	1	0
	45-49	0	0	0	0	0	1 AT 2 MONTHS 1 AT 36 MONTHS	0	0
	TOTAL	1	1	0	1	0	6	3	2
NET TOTAL	2		1		0	6 (54.5%)	5		

Whether or not the metabolic activity of the fibroblasts is also affected is more difficult to hypothesize. While one might expect a response to radiation such as is shown by many keloids, nevertheless, in several instances, check roentgenograms have shown advancement of the ligamentous calcification and fusion of the articular processes in a symptom-free patient. Furthermore, no alteration has been detected in those cases which have progressed to ankylosis and extensive calcification of the paraspinal ligaments.

405 North Bedford Drive.

REFERENCES

1. Anders, J. M., Daland, J. and Pfahler, G. F.: The treatment of arthritis deformans with the roentgen rays, *J.A.M.A.*, 46:1512-1514 (May 19), 1906.
2. Angevine, D. M.: The pathology of rheumatic diseases, *Radiology*, 49:1-7 (July), 1947.
3. Baker, L. D.: Rhizomelic spondylitis: orthopaedic and roentgen therapy, *J. Bone and Joint Surgery*, 24:827-830 (Oct.), 1942.
4. Freyberg, R. H.: Roentgen therapy for rheumatic diseases, *Med. Clin. N. A.*, 30:603-615 (May), 1946.
5. Hemphill, J. E. and Reeves, R. J.: Roentgen irradiation in the treatment of Marie-Strumpell disease, *Am. J. Roent. & Rad. Ther.*, 54:282-289 (Sept.), 1945.
6. McWhirter, R.: Ankylosing spondylitis, *Brit. J. Rad.*, 18:302-305 (Oct.), 1945.
7. Pohle, Ernst A., and Morton, James A.: Roentgen therapy in arthritis, bursitis and allied conditions, *Rad.*, 49:19-24 (July), 1947.
8. Scott, S. G.: Wide field roentgen therapy, *Am. J. Roent. and Rad. Ther.*, 43:1-16 (Jan.), 1940.
9. Smyth, C. J., Freyberg, R. H. and Lampe, I.: Roentgen therapy for rheumatoid arthritis of the spine, *J.A.M.A.*, 117: 826-831 (Sept. 6), 1941.
10. Steinberg, C. L.: The pathology of atrophic arthritis, *J. Lab. and Clin. Med.*, 27:435-443, 1942.



78th Annual Session
California Medical Association
Los Angeles
May 8 - May 11, 1949